METHOD AND APPARATUS FOR A CABLE TV SERVER

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METHOD AND APPARATUS FOR A CABLE TV SERVER

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of prior filed U.S. Provisional Application 60/202,338 filed on May 5, 2000 entitled "*WEBCASTER*" (Attorney Docket ICTVP002P) by inventors Mitchell Askenas et. al. which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention pertains to television systems, particularly digital headend content distribution systems.

2. Description of the Related Art

Cable television systems have not yet achieved the promise of the 500 channel TV set, largely due to bandwidth constraints for delivering the channels to the subscribers over cable plant. Although a coaxial cable system may permit a cable system operator to provide, for example, 50 television channels, each 6 MHz wide, with a total bandwidth of 300 MHz, this total bandwidth is insufficient to permit an arrangement wherein each subscriber may have, in addition to these 50 channels, an additional 50 to 450 channels.

Communication with a subscriber begins at the headend and proceeds over a communication path that involves one of a number of trunks, and then over one of a number of feeders, then over one of a number of taps. Each feeder may have, for example, fifty or more subscribers, and each trunk might serve a hundred or more feeders. The result is that 500 subscribers per trunk is not atypical. Thus merely to provide a private one-way information service, and nothing else, to each of these 5000 subscribers would require the trunk to carry 5000 different signals, each using about 6MHz of bandwidth, and would alone require a trunk bandwidth of 30 GHz, which is nearly two orders of magnitude greater than provided by a typical coaxial cable system.

What is needed is a low cost, low bandwidth means for delivering content to cable television subscribers.

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus for providing low bandwidth and low cost content to cable television subscribers. The apparatus involves an inexpensive web content server which can be integrated with existing cable headends and which can deliver up to 50 discrete digital channels on a single 6MHz bandwidth slot. The web content server includes an administrative tool which allows quick provisioning and configuring of existing channels. The web content server generates a set of browser instances with each browser instance cycling through its own unique set of web pages. The web pages may be stored locally on the web content server or located globally on the Internet or other wide area network (WAN) or local area network (LAN). The web server periodically captures digital images corresponding with the web pages displayed by each browser instance and individually processes each as a discrete digital channel. The digital channels are multiplexed onto a single 6MHz analog channel. At the set top box or the TV itself each image stream corresponding with each browser instance is presented to the subscriber as a separately selectable channel. The content may be used to deliver any information currently available on the Internet, or generated locally as Web pages.

In an embodiment of the invention a cable television headend is provided for delivery of cable television channels to a plurality of subscriber televisions. The cable system headend includes: a generator, a controller, a compressor and a multiplexer. The generator generates a first browser instance which displays a first set of web pages and at least a second browser instance which displays at least a second set of web pages. The controller controls the first browser instance and the at least second browser instance to periodically capture images corresponding with the first set of web pages and the at least a second set of web pages. The compressor couples to the controller to compress the periodically captured images corresponding to one of the first browser instance and the at least second browser instance. The multiplexer multiplexes the periodically captured images for delivery to the subscriber televisions.

In another embodiment of the invention a method for delivery of cable television channels to a plurality of subscriber televisions is disclosed. The method comprises:

generating a first browser instance displaying a first set of web pages and at least a second browser instance displaying at least a second set of web pages;

determining for the first browser instance and the at least second browser instance corresponding intervals for updating images corresponding with the first set of web pages and the at least a second set of web pages;

capturing images corresponding with the first set of web pages and the at least a second set of web pages at the corresponding intervals determined in said act of determining;

compressing the periodically captured images corresponding to one of the first browser instance and the at least second browser instance; and

multiplexing the periodically captured images for delivery to the subscriber televisions.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will become more apparent to those skilled in the art from the following detailed description in conjunction with the appended drawings in which:

FIG. 1 shows the overall system environment showing a plurality of Cable TV subscribers coupled across a cable plant to a cable headend which includes a web content server for delivery of a plurality of low bandwidth digital channels to the user on a single selected analog channel.

FIG. 2 is a hardware block diagram of a computer suitable for implementing the web content server shown in FIG. 1.

FIG. 3 is a software block diagram of the web content server shown in FIG. 2.

FIGS. 4A-C show the graphical user interfaces associated with administrative setup of the web content server shown in FIGS. 1-3.

FIGS. 4D-E show the graphical user interfaces associated with viewing, inserting, and modifying selected ones of the content carousels associated with each low bandwidth digital channel provided by the web content server shown in FIGS. 1-3.

FIG. 5 shows a master web page for a channel. The master web page is generated in a markup language for defining content associated with a single digital channel.

FIGS. 6A-B show the channel and system setup tables respectively.

FIG. 7 is a process flow diagram for the web content server shown in FIGS. 1-3.

FIG. 8 is a detailed process flow diagram of the bandwidth regulating and multiplexer processes performed in the bandwidth controller and the multiplexer shown in FIG. 3.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention provides a method and apparatus for providing low bandwidth and low cost content to cable television subscribers. The apparatus involves an inexpensive web content server which can be integrated with existing cable headends and which can deliver up to 50 discrete digital channels on a single 6MHz bandwidth slot. The web content server includes an administrative tool which allows quick provisioning and configuring of existing channels. The web content server generates set of browser instances with each browser instance cycling through its own unique set of web pages. The web pages may be stored locally on the web content server or located globally on the Internet or other wide area network (WAN) or local area network (LAN). The web server periodically captures digital images corresponding with each of the browser images and individually processes each as a discrete digital channel. Each digital channel is multiplexed onto a single 6MHz analog channel. At the set top box or the TV itself each image stream corresponding with each browser instance is presented to the subscriber as a separately selectable channel. The content may be used to deliver any information currently available on the Internet.

FIG. 1 shows the overall system environment showing a plurality of Cable TV subscribers coupled across a cable plant to a cable headend which includes a web content server for delivery of a plurality of low bandwidth digital channels to the subscriber's TV on a single selected analog channel. The cable head end facilities include a plurality of broadcast TV receivers accepting a downlink from satellite 144 via receiver 146. The "N" broadcast channels are each delivered in an corresponding analog 6MHz channel along signal line 150 to a directional coupler 154 where they are inserted into the cable plant 166 via a forward laser 160 and a circulator 164. The circulator may provide a return path 162 from the subscribers. In addition to this traditional headend structure the current invention provides for the utilization of a single additional 6MHz bandwidth slot for the injection of 50 or more additional channels. The channels are generated by the web content server a.k.a. carousel server 100. The carousel server allows the authoring, setup, generation, control and injection of 50 or more discrete digital channels into the broadcast stream from the headend.

Block 102 shows the basic software modules which make up the carousel server. The carousel core 104 handles the authoring, setup generation and control of a plurality of instances 108, 122 of a browser application, such as Internet Explorer ®, Microsoft Corp. Redmond Washington. Each browser application follows its own "slide" carousel format as governed by an associated HTML master page (See FIG. 5). The "slides" of each carousel are the web pages displayed by each carousel. The carousel server 100 is coupled to the Internet 134. The web pages which provide the content for the "slide carousel" provided by each browser instance may be stored locally or accessed, as in the case of web pages 136, over the Internet. There is one browser instance with its corresponding individual carousel per channel.

Browser instance 108 cycles through a carousel of web page(s) which includes web page 110 which displays snow and slope conditions from the home page of a ski resort selected by the content provider to be part of this channel, e.g. the "Snow Report" channel 150. This browser instance provides the content for digital channel 150.

Browser instance 122 generates a carousel of web page(s) which includes web page 124 which displays streaming video clips of the latest movie releases. The web page 124 is selected by the content provider to be part of this channel, e.g. the "Movie Review" channel 149. The images from each browser instance are captured by the carousel core at intervals which are programmed for each channel during channel authoring or setup. The carousel core provides compression of each image in a suitable image compression format. In an embodiment of the invention compression follows the Motion Picture Expert Group compression standard MPEG2. Each channel is output by the carousel core in compressed form as an elementary stream. Typically the reload, capture or refresh interval for each channel is one or two orders of magnitude less than the image capture rate for a normal video stream in which 30 frames are captured every second. This greatly reduces the bandwidth requirements and allows more channels to be carried on a 6 MHz analog channel. In MPEG terminology, the MPEG compressor will typically only output "I" frames for each channel and will avoid creation of "B" or "P" frames. Elementary streams 112 and 126 corresponding with browser instances 108 and 122 respectively are shown.

In an embodiment of the invention each browser uses its own compressor component. In another embodiment of the invention a single compressor component constructs separate elementary streams from the encoded "I" frames corresponding to the images from each browser. This works because the encoded "I" frame are independent of adjacent "I" frames from the other channels.

The multiplexer 106 receives these elementary streams and converts them to transport streams which are subject to modulation in quadrature amplitude modulation (QAM) module 140 and upconversion to radio frequency (Rf) in Rf uplink module 142. This multiplexed digital transport streams are injected via signal line 152 into the directional coupler 154 with the "N" analog broadcast TV channels and are then inserted into the cable plant 166 via the forward laser 160 and circulator 164. The transport stream (TS) includes TS packets for each digital channel. The TS packets 114 and 120 are shown with payload corresponding with channel 150, the "Snow Report" channel. The TS packets 128, 130 are shown with payload corresponding with channel 149, the "Movie Review" channel. Each packet has a 4-byte header that includes a packet identification code (PID) and a payload. For packet 114 the header 116 and payload 118 are shown. The packets are of fixed-length, i.e. 188 bytes long. All packets carrying the same elementary stream have the same PID. A sequence number in the packet header ensures that the packets are decoded in the associated set top box.

Each transport stream also includes other TS packets that contain the program mapping table (PMT) for each program and the program association table (PAT) for the entire stream. The payload of the PAT packet contains the service numbers and corresponding PMT PID numbers for each program. The payload of the PMT packet contains the program clock reference (PCR) PID and elementary stream (ES) PID for the corresponding program (See FIG. 4A). In an embodiment of the invention the programs use a common PCR stream which contains timing information for all the programs in the TS.

The subscriber side shows three subscribers each with an associated TV, remote control, and set top box combination which are coupled via node 168 to the cable plant. TV 182 couples to the cable plant via set top box 186. Remote control

184 is used to set the set top box 186 to the appropriate selection of either a digital or analog channel. In the example shown the user has selected the "Movie Review" channel 149. The set top box 186 periodically refreshes its image buffer with the "I" frames contained in the corresponding TS packets. One of those I frames corresponds with image 124 originally generated by the browser instance 122 in the carousel server on the cable headend. The contents of the image buffer of the set top box 186 are decompressed and displayed on the subscribers TV 182.

TV 176 couples to the cable plant via set top box 180. Remote control 178 is used to set the set top box 180 to the appropriate selection of either a digital or analog channel. In the example shown the user has selected the "Snow Report " channel 150. The set top box 180 periodically refreshes its image buffer with the "I" frames contained in the corresponding TS packets. One of those I frames corresponds with image 110 originally generated by the browser instance 108 in the carousel server on the cable headend. The contents of the image buffer of the set top box 180 are decompressed and displayed on the subscribers TV 176.

TV 170 couples to the cable plant via set top box 174. Remote control 172 is used to set the set top box 174 to the appropriate selection of either a digital or analog channel.

The practice of the current invention is not limited to a cable plant distribution medium. Distribution from headend to subscriber could alternately be made by alternate wired mediums such as XDSL or via wireless mediums such as satellite.

FIG. 2 is a hardware block diagram of a server suitable for implementing the web content server shown in FIG. 1. The server 100 includes at least one processor 210 for processing information. The processor couples via a bus 212 with Input/Output (I/O) devices 214, network device 216, uplink device 218, main and read only memories 220-222 and mass storage device 224. The I/O device 214 may include keyboard and display. The network device 216, wired or wireless, couples the server with the Internet 134, or other wide area network (WAN) or local area network (LAN). The uplink device couples to the uplink module 138 for modulating the transport streams onto the analog TV channel. The main memory 220 stores information and instructions for the processor. The read only memory 222 stores

static information and boot instructions for the server. The mass storage device 224, such as magnetic disk and associated disk drive, couples with the bus 200 for storing information and instructions on the storage medium 200. The storage medium contains: program code 202, setup tables 204, administrative web pages 206 and may also include content pages 208. Content pages 136 may alternately be found on the Internet 134.

FIG. 3 is a software block diagram of the web content server shown in FIG. 2. The carousel server 102 includes: core module 104, multiplexer 106, a database server 316 and the various data structures. The data structures include administrative web pages 206, program code 202, setup table 204 and content web pages 208. The core includes a network interface 300, an administrative module 302, a carousel generator 304, a carousel controller 306, and a digital image processing portion comprising the image capture and conversion module 308 and MPEG compressor 310.

The NIC 300 couples to the Internet 134, to provide an alternate source for channel content. The multiplexer 106 couples with the uplink module 138 shown in FIG. 1. During an administrative phase of operation the administrative module 302 controls user login and access to one or more of the administrative web pages 206. These pages (See FIGS. 4A-E) include forms for the input and update of the setup and channel parameters for the carousel server. As the user enters the data the administrative server writes the data to the appropriate table and record within the setup tables, e.g. the channel table 600 and the setup table 602 shown in FIGS. 6A-B. For each new channel a corresponding master HTML page is defined. That page may be stored locally as one of the content pages 208 or may be located on the web as indicated by web pages 136 shown on the Internet.

At the completion of the administrative phase the generation module 304 generates a number of browser instances 108, 122 and 334, corresponding to the number of channel records in the channel control table 600. Each browser is initialized at its own corresponding master HTML page (See FIG. 5 for example) indicated in the starting URL field 470 of the associated record in the channel table 600 (See FIG. 6A). In the example shown browser instance 108 is initialized at HTML master page 208 shown in FIG. 5. This page has its own URL. Pages which are subsequently displayed

in the <IFRAME> structure within the corresponding HTML master page 208 may themselves be stored on the server of may be found on the Internet. A browser instance 108 is shown displaying web page 110 within the <IFRAME> element. The page displayed includes URL 332. That URL will not provide an active link when it is displayed on the users screen. A browser instance 122 is shown generated by the generation and control module 304. That browser instance displays page 124 within the browsers view window. Within the <IFRAME> element of that page a streaming video 344 is shown displaying film clips. The generation module has also spawned a third browser instance 334 the content of which is controlled by the associated one of the HTML master pages 208. The controller 306 maintains active API links with each browser instance. Through these links the controller is able to determine when a particular browser instance has finished loading a new web page. The timing of these page loads may be determined by a program written in a script language and made part of the master page (See FIG. 5) which the corresponding browser instance then executes to cyclically display pages in the <IFRAME>. Alternately, for other browser instances such as browser instance 122 the controller determines the appropriate reload or capture intervals for the channel from the corresponding record in the channel table 600 (See FIG. 6A). The controller causes the digital processing stage to periodically capture each browser instance's associated carousel images at time intervals determined either by the script in the master page or by the reload or capture parameters for the associated channel.

The digital processing stage includes the image capture and conversion module 308 and MPEG compressor 310. The image capture and conversion module is directed by the controller to periodically capture each browser instance's associated carousel images and to convert these from RGB format to a YUV image which is the preferred image format for MPEG2 compression. The MPEG2 compression is the next phase of operation and is performed successively for each browser instance by the MPEG compressor 310. The bandwidth accorded to each browser instance is governed under the direction of the controller by the encode bitrate parameters 480 and channel bitrate parameters 478 for the corresponding channel which are stored in the channel table 600 (See FIG. 6). The MPEG compressor outputs elementary streams for each browser instance. These elementary streams consist largely of "I"

frames since the image update frequency for any channel is so slow in comparison to a normal video stream with 30 frames per second per channel being the norm. Here seconds may elapse before a subsequent image is processed for any channel. Each compressed image out of the MPEG compressor forms part of an elementary stream for the corresponding channel. The elementary streams 112 and 126 for channels 150 and 149 respectively are shown. These elementary streams are assigned a corresponding transport control protocol internet protocol (TCP/IP) port number which is the manner in which they are presented to the input of the multiplexer, i.e. as a inputs on a plurality of ports 314. Each port is associated with a corresponding channel, a corresponding browser instance. The output of the multiplexer is a transport stream with includes TS packets for each of the active channels. These are passed to the uplink module 138.

In an alternate embodiment of the invention the carousel server may be coupled with alternate communication mediums wired and wireless to deliver TV channels to subscribers. Alternate communication mediums include: subscriber line direct to the home or satellite direct to the home for example. In these embodiments the multiplexer output would be passed to the appropriate modulator for transport on the wired or wireless communication medium.

FIGS. 4A-E show several of the web pages presented by the administrative module 302. The administrative module 302 provides administrative web pages 206 to configure the system and information channels a.k.a. "carousels". In an embodiment of the invention the module may additionally provide for: machine view; status; modification and addition of users and content providers and help.

FIGS. 4A-C show the graphical user interfaces associated with administrative setup of the web content server shown in FIGS. 1-3. FIGS. 4D-E show the graphical user interfaces associated with viewing, inserting, and modifying selected ones of the content carousels associated with each low bandwidth digital channel provided by the web content server shown in FIGS. 1-3. Each screen is shown as a browser based graphical user interface with a menu frame 404 on the left and a main frame on the right. The page displayed in the main frame depends on the user menu selection. In an alternate embodiment of the invention user interfaces would be windows based rather

than browser based. The pages shown in the following FIGS. 4A-E are presented to an administrator after a successful user login from a login screen (Not shown).

In FIG. 4A the administrator has selected menu choice 420 which is the channel map. This selection results in the display of page 402 in the right hand frame of the browser 400 view area. The channel map handles input and update of channel map parameters in a form with input fields for the: 1st virtual channel 430, the 1st program mapping table packet identification code (PMT PID) 432, the 1st service number 434, the maximum number of channels 436, the PID increment 438, the 1st video PID 440 and the transport control protocol (TCP) port offset 442. A submit element 416 on the page 402 allows for input or update of the values of these fields and entry of the associated field of information into the system setup table 602 (See FIG. 6B). This table is part of the setup tables 204 which are accessible by the carousel module 104 via the database server 316 shown in FIG. 3. The 1st virtual channel field 430 identifies the first virtual channel number for the range used by the carousel server. The virtual channels will be numbered from the first virtual channel to the first virtual channel plus the maximum number of channels minus one. The virtual channel numbers are assigned by local or national cable plant personnel. The virtual channel number is part of the channel map which is downloaded to every one of the set top boxes 174, 180 and 186 shown in FIG. 1. The virtual channel number is the number displayed to the user by the set-top box or channel guide. The 1st program mapping table packet identification code (PMT PID) 432 is the MPEG stream number for the PMT for the first virtual channel. The PMT PID for the remaining virtual channels are incremented by the PID increment 438. All PMT PIDs must be in the range 17-8190. Each PMT PID must be different for each of the video PIDs. The value is usually 17. The 1st service number 434 gives the service number or MPEG program number for the first virtual channel. This number is local to the MPEG transport stream for a given analog carrier frequency. The remaining virtual channels use the next higher service numbers. All service numbers must be in the range 1-65535. The value is usually set to 1. The maximum number of channels field 436 indicates the maximum number of channels which will be supported in the MPEG transport stream. Each of these possible channels will be given an equal share of the available bandwidth. This value is typically 30. The PID increment 438 indicates the

change in PMT PID values for increasing virtual channels and also the change in video PIDs. The value is typically 4. The 1st video PID 440 is the MPEG stream number for the video data for the first video channel. The video PIDs for the remaining virtual channels are incremented by PID increment. All video PIDs must be in the range 17-8190. This value is typically 18. The transport control protocol (TCP) port offset 442 is the number added to the virtual channel number to determine the TCP socket used by the MPEG digital multiplexer 106 to receive MPEG data from the MPEG compressor 310 in the carousel.

In FIG. 4B the administrator has selected menu choice 422 which is the channel format. This selection results in the display of page 406 in the right hand frame of the browser 400 view area. The channel format page handles input and update of channel format parameters in a form with input fields for the aspect ratio and margins of the screen image. Fields 448-454 accept the user inputs for the left, right, top and bottom screen margins respectively. Fields 444-446 accept user inputs for the width and height respectively of the actual image displayed on the TV. The values are in multiples of 16 with a recommended value of 640 for the width and 480 for height. The submit element 416 on the page 406 allows for input or update of the values of these fields and entry of the associated field of information into the system setup table 602 (See FIG. 6B).

In FIG. 4C the administrator has selected menu choice 424 which is the setup parameters for the multiplexer 106 (See FIG. 3). This selection results in the display of page 408 in the right hand frame of the browser 400 view area. The multiplexer setup page handles input and update of multiplexer parameters in a form with input fields for the: transport stream ID 456, total bandwidth 458 and available bandwidth 460. The transport stream ID provides the MPEG stream ID number. The value is typically in the range of 1 to 65535. The total bandwidth is the analog carrier bandwidth in MHz. For the United States this value should be 6. The available bandwidth is the amount of analog carrier bandwidth that may be used for the various carousels controlled by the carousel core 104 (See FIG. 1). The submit element 416 on the page 408 allows for input or update of the values of these fields and entry of the associated field of information into the system setup table 602 (See FIG. 6B).

In FIG. 4D the administrator has selected menu choice 426 which is the carousel view. This selection results in the display of page 410 in the right hand frame of the browser 400 view area. This page provides information on each carousel/channel that the user is allowed to access. Each screen displays a predefined number of carousels. The information is dynamically updated. The defined carousel statuses are as follows: *Inactive. Active, Crashed, Bad URL, Pending and Unknown.* For each carousel, the status, channel number, channel name and URL currently displayed on the channel are displayed. The <backward> and <forward> buttons allow the user to page backward and forwards through the various channels. If a particular Channel Number (a.k.a. Carousel) is selected while within the *Carousel View* page 410, the *Modify/Input Carousel* page 412 is displayed. This page is the substantially the same page displayed when a user selects insert channel menu item 428 from the menu page 404. The difference between the two access paths to this page is that in the modify case the page form input elements display the parameters currently in the associated record in the channel table 600 (See FIG. 6A) and may additionally include current status information for the carousel. In the insert carousel case the form input elements contain null entries initially and no status information since the channel is not yet established.

The *Modify/Input Carousel* page is shown in FIG. 4E. The channel number field 464 allows entry of the channel number assigned to the carousel. This value is typically from 1-4095. The channel name field 466 allows entry of the channel name assigned to the selected channel/carousel. The starting uniform resource locator (URL) field 470 allows entry of the start up path or web address for the master HTML page 208 (See FIG. 5) of which there is one for each channel. The URL that is loaded when the carousel starts. The program ID field 482 allows user input of the program ID for the associated channel. The program ID has a typical value from 1-65535. The PID field 484 allows user entry of a value corresponding with the PMT rate in the transport stream output of the multiplexer 106 (See FIG. 3). The PMT field 486 allows user entry of the program mapping table ID. The channel bit rate field 478 allows user input of a value which controls the image quality and refresh frequency of the MPEG frames. Values typically range from 10,000 - 10,000,000 bps. The encoding bit rate field 480 allows user input of a value which controls the maximum

amount of data, typically 1,000,000 - 10,000,000bps, that is sent out per second. The reload interval field 474 allows user input of a value corresponding with the time period, typically 2,000-3,600,000 mSec at which the URL is reloaded. This field is not used if the HTML field 472 is set to TRUE, because the HTML script will control the update parameters. The capture interval field 476 allows user input of a value corresponding with the time period, typically 2,000-3,600,000 mSec at which the URL is captured without having to reload the web page. This field is not used if the HTML field 472 is set to TRUE, because the HTML script will control the update parameters. The HTML field 472 allows user selection of Boolean "TRUE" or "FALSE" values. These values define how the carousel core 104 will process the start URL field 470. If the HTML field 472 is TRUE, then the start URL field must contain a web page that defines which web pages are displayed and at what rate pages are updated and changed. If the field is FALSE, then the start URL field contains a web page that is updated or reloaded as defined by the reload and capture interval fields. Typically the reload, capture or refresh interval is one or two orders of magnitude less than the image capture rate for a normal video stream in which 30 frames are captured every second. This greatly reduces the bandwidth requirements and allows more channels to be carried on a 6 MHz analog channel. In MPEG terminology, the MPEG compressor will typically only output "I" frames for each channel and will avoid creation of "B" or "P" frames.

Where the page 412 is for an existing channel which is being modified the following information may additionally be provided: the current state of the carousel; the URL currently displayed, the # of unsuccessful loads of the URL, the time at which the carousel was started and the last refresh, capture and load times. Additionally, where more than one carousel is being operated in a clustered format the IP address of the master carousel may also be displayed. The Carousel status is updated at the bottom of screen for each command. The supported carousel *States* are as follows: *Inactive, Active, Crashed, Bad URL, Pending and Unknown*. The submit icon 416 allows user entry of the parameters in the form 412 to the associated record in the channel table 600 shown in FIG. 6A. Additional interfaces may be added to reset, start, stop, remove or refresh the associated carousel/channel.

In alternate embodiments of the invention additional administrative screens may be added for setting up various accounts and privileges to each of the above mentioned screens for users including content providers. Screens may also be added to handle multiple servers working in a clustered arrangement.

FIG. 5 shows a master web page 208 for a channel (See FIG. 2). The master web page defines content associated with a single digital channel. There is one master web page for each channel. The master page may be formatted in several different ways depending on the channel to be displayed. In FIG. 5 the master page for the "Ski" channel associated with the browser instance 330 in FIG. 3 is shown. That page includes a persistent portion and a cyclic portion. The cyclic portion is defined by the embedded floating frame in which a slide carousel of additional web page(s) may be displayed. The persistent portion is the remainder of the page which remains in the browsers view window throughout the session. Within the cyclic portion the set of web pages defined in array 500 are cyclically displayed, for time intervals determined by the script embedded in the persistent portion of the page.

The embedded cyclic frame portion is formed from an HTML element identified as an "Iframe" which is currently specifically supported by Internet Explorer ® Microsoft Corporation Redmond, Washington. This element departs from the standard FRAME structure syntax. This in-line framing method (also called "floating frames") is basically a method to embed other HTML documents within the framework of a regular HTML document structure with the level of placement control allowed by the IMG element. In implementation and display it is created and treated much like the OBJECT element. The <IFRAME> hypertext markup language (HTML) floating frame element 508 is embedded in the master page. The contents of the floating frame are cycled at a predefined time interval in round robin fashion between the web sites of the various ski areas selected by the content provider. The pages displayed list among other information the snow levels and ski conditions at each ski resort. The URLs for the web pages to be displayed sequentially in the <IFRAME> are contained in a carousel array 500 which may contain any number 1-N of URLs. The page also includes three functions 502, 504, 506 written in a script language for cycling the URLS in the array 500 within the frame element 508. The script language shown is

JavaScript ® Netscape N.Y., New York. Other script languages may be used. The browser instance for the corresponding channel executes the script in the master HTML page 208 when the page is loaded thus cycling the image displayed in the <IFRAME> portion 508 of the page 208 in round robin fashion among the various web sites represented by the URLS in the carousel array 500. This type of master HTML page allows controls the timing of uploading and display of each URL. As the corresponding URL is uploaded the generator and control module 304 of the carousel core 104 (See FIG. 3) is notified via an associated API of the browser instance. When the channel record for which this page is the starting URL is established the value of HTML field 472 would be set to Boolean "TRUE" indicating that the master page is to control the timing of page update and change. Other HTML master pages for other channels could follow the same or a different format. In an alternate embodiment of the invention a master page may in fact include both a persistent parent frame set, and associated persistent and cyclic child frame pages. In this embodiment of the invention the persistent one of the child frame pages contains the script referred to above the effect of which is to change the page displayed in the therefore cyclic child frame.

The master page for the "Movie Review" channel shown in the browser instance 342 in FIG. 3 might show a single page in which the page or a frame element thereof would display an active graphical element, e.g. a streaming video of various movie previews. The sequencing from one preview clip to another would be provided by the content provider as part of the streaming video. For this type of master page there would be no page cycling. Thus in the associated channel record the value of the HTML field 472 would be set to Boolean "FALSE" indicating that the master page does not control the timing of page update and change. Instead the user would setup the channel record with the appropriate value for the capture interval in field 476. At the end of each capture interval the generator and control module 304 would cause the image grabber 306 to capture the page.

In other embodiments of the invention the HTML master page might be a persistent page with no cyclic page. Such a page might for example contain stock market data updated from time to time by the content provider. For the channel corresponding with this type of master HTML page the channel record value of

HTML field 472 would also be set to Boolean "FALSE" indicating that the master page does not control the timing of page update and change. Instead the user would setup the channel record with the appropriate value for the reload interval in field 474. At the end of each reload interval the generator and control module 304 would cause the browser instance to reload the page and the image capture and converter 308 to capture the page after reloading.

FIGS. 6A-B show the channel and system setup tables respectively. These individual tables are part of the set of setup tables 204 shown in FIGS. 2-3. The channel table 600 shown in FIG. 6A contains individual setup records for each of the channels. Each record contains a plurality of setup parameter fields, e.g. fields 462-486 for identifying the channel name, starting URL, refresh/reload/capture interval, bandwidth requirements and various elementary stream and transport stream identifiers. These records were input by the administrator/user via input pages shown in FIGS. 4D-E. The system setup table 602 shown in FIG. 6B contains the system parameters for each analog channel including: channel mapping, channel format, and bandwidth allocation for the combined channels as input by the user via input pages shown in FIGS. 4A-C.

FIG. 7 is a process flow diagram for the web carousel server shown in FIGS. 1-3. Processing begins at start block 700 in which system initialization is performed. Next in decision process 702 a determination is made as to whether a successful administrative login has taken place. This determination is made by the administrative module 302 (See FIG. 3) using user name and password information. If an administrative login has taken place then control passes to process 704 in which the administrator may select among the administrative Web pages 402,406-412 shown in FIGS. 4A-E to set system parameters or to add or update parameters for existing channels. In process 706 the parameters updated or entered by the user via the forms on any of the administrative web pages are written to either the channel or system set up tables 600-602 respectively shown in FIGS. 6A-B. Control is then passed to process 708. Process 708 is the same process reached directly from decision process 702 when there is no administrative login.

In process the 708 the generator 304 of the carousel server 102 determines which channels are to be activated from the parameters stored in the channel set up

table 600 shown in FIG. 6A. These parameters were loaded into the channel set up table during the administrative access in processes 704-706. The generator then initializes a browser instance for each channel in the channel setup table. An associated interval timer or similar software construct is initialized in main memory 220 (See FIG. 2) for each channel for which the "HTML" field parameter is FALSE. These timers allow the reload or capture interval to be determined for the associated channel. In process 710 each browser is initialized with a respective starting URL 470 for that channel as indicated in each channels record in channel table 600. The starting URL points to the master HTML page 208 for each corresponding channel. The master page for each channel may be stored on the carousel server or may be available over the Internet 134. Each channel will independently begin cycling through the one or more HTML pages indicated in the Carousel list in the master HTML page 208 for each channel (See FIG. 5). These pages will be cyclically displayed in the cyclic portion of the master page, e.g. the <IFRAME> structure.

Next in decision process 712 the processes associated with image capture and compression are commenced. In decision process 712 a determination is made by the controller as to whether the next channel, i.e. the next active browser, is to be serviced. This decision can be made on the basis of interrupts generated by the browser instances running as independent "threads" or processes, when a new or refreshed HTML page is present in the corresponding browser or the decision can be made on the basis of a fixed round-robin sequence in which the controller services each of the browser instances. Next in process 714 the parameters for the channel to be serviced are obtained from the associated record in the channel setup table 600 shown in FIG. 6A.

Then in decision process 716 a determination is made as to whether the parameter in HTML field 472 of the associated channel record in table 600 is Boolean "TRUE" or "FALSE". If the Boolean value is TRUE control is passed to decision process 730. In decision process 730 a determination is made by the controller 304 as to whether the browser instance which is being serviced has generated an interrupt or other indication that a new page has been loaded. If not, control passes to decision process 712 for the servicing of the next channel. If however the channel being serviced has indicated via interrupt, or other application interface that a new page has been loaded then the control is passed to process 740 for capture of the image

displayed in the inline frame element 508 of the corresponding master HTML page 208 (See FIG. 5).

If alternately in decision process 716 a determination is made that parameter in the HTML field 472 of the corresponding channel record is Boolean "FALSE" then control is passed to process 718. In process 718 the value of the interval timer for the associated channel is determined. The timer allows the reload or capture interval for the associated channel to be continuously tracked. The simplest form of timer is a count down timer with the count down value re-initialized with each frame grab at the value for whichever of a reload or capture parameter for the associated channel is indicated in fields 474-476 of the associated channel record (See FIG. 6A). Next in decision process 720 a determination is made as to whether the reload or capture interval for the associated timer has elapsed. If not control returns to decision process 712 for the servicing of the next channel. If the associated countdown timer has elapsed than control passes to decision process 722.

In decision process 722 a determination is made as to whether the record for the associated channel is one which calls for a reload interval in field 474 or a capture interval in field 476. If the channel is one which calls for a capture control is passed to process 728. A channel that requires a capture at a given interval is a channel which does not require reloading of the web page. This type of channel is appropriate where the corresponding web page(s) embed streaming video, Active X ® or Power Point ® Microsoft Corporation, Redmond Washington, presentations. In process 728 the interval timer for the corresponding channel is reset with the capture interval value stored in capture field 474 of the channel record. Control is then passed to process 740 in which the image capture, i.e. frame grab for the associated channel is effected by the frame grabber 306 under the direction of the controller 304 (See FIG. 3).

Alternately, if it is determined in decision process 722 that the associated channel is set up for reloading at a reload interval then control is passed to process 724. In process 724 the browser that is being serviced is directed by an API initiated by the controller 304 to reload the current page. Control is then passed to process 726 in which the interval timer for the corresponding channel is reset with the capture interval value stored in the capture field 476 of the channel's associated record in channel table 600 (See FIG. 6A). Control is then also passed to process 740.

In process 740 the image capture for the associated channel is effected by the image capture and conversion module 308 under the direction of the controller 306 (See FIG. 3). Control is then passed to process 742 in which the RGB digital image captured by the image capture and conversion module is converted to YUV format which is the input format used by MPEG2 compression systems. Control next passes to process 744 in which the converted image is subject to MPEG compression in the MPEG compressor 310 shown in FIG. 3. Next in process 746 the images for each channel are assigned a corresponding elementary stream and port number. Then they are passed to the bandwidth control 312 and the multiplexer 106 (See FIGS. 1,3). The processes including bandwidth control in the multiplexer are set forth in greater detail in the following FIG. 8. Control then returns to decision process 712 for the servicing of the next browser instance, i.e. the next channel.

FIG. 8 is a detailed process flow diagram of the bandwidth regulating and multiplexer processes performed in the bandwidth controller 312 and the multiplexer 106 shown in FIG. 3. Processing begins in start block 800 in which the system is initialized. Control then passes to process 802 which clears the bandwidth budget for all channels. Control then passes to process 804 in which the number of bits for each channel in a relevant measuring period is calculated. The National Television Standards Committee (NTSC) proscribes a frame rate of 29.97 frames per second for a broadcast television channel. This is the interval chosen to regulate bandwidth for each channel on the transport stream. The total usable bitrate is derived from field 460 of system table 602 (See FIGS. 4C-6B) by subtracting the bitrate required for PMT, PAT, PCR packets and a small reserve. The bitrate for one channel is determined by dividing the total usable bitrate by the product of the number of channels times the frame rate. Control is then passed to process 806 in which the next frame period is awaited. At the start of the next frame period control is passed to process 808 in which the 1st channel is chosen. Control is then passed to process 812 in which the bit budget increment per frame period calculated in process 804 is added to the bandwidth budget for this channel. Control is then passed to decision process 814. In decision process 814 a determination is made for this channel as to whether there is a new PES packet. If there is not, control passes to decision process 818. If there is a new PES packet control passes to process 816 in which the new PES packet is saved in a

channel buffer which is kept for this and every other channel by the multiplexer, after which buffering control is also passed to decision process 818. In decision process 818 a determination is made as to whether there is a saved PES packet stored in the corresponding buffer and whether the current bandwidth budget for the channel being processed is greater than or equal to the size of the PES packet. If it is, then in process 820 the bandwidth budget for this channel is decremented by the size of the packet, and then in process 830 the corresponding PES packet is sent and control is passed to decision process 832.

Alternately, if in decision process 818 the current bandwidth budget for the channel does not exceed the size of the PES packet in the corresponding buffer then control is passed to decision process 822, in which a determination is made as to whether a dummy "P" frame needs to be sent. That determination itself rests on one of two conditions: a) if a PES packet was sent in the previous frame interval a dummy "P" frame is sent or if the time elapsed since the last packet was sent for this channel exceeds that required for proper performance of the set top box then a dummy "P" frame is sent to keep the communication stream to the set top box or TV active for this channel. If a determination is made that no dummy "P" frame needs to be sent then in process 828 nothing is sent and control passes directly to decision process 832. Alternately, if a "P" frame is to be sent then in process 824 the bit budget for the channel is decremented by the size of the dummy "P" frame and control is passed to process 826 in which the corresponding dummy "P" frame is sent. Subsequently control is passed to decision process 832. In decision process 832 a determination is made as to whether more channels remain to be processed in this frame period. If so control passes to process 810 for selection of the next channel and subsequent processing in process 812. If no more channels remain to be processed in this interval then control returns to process 806 to await the start of the next frame period.

In multiplexor 106 (See FIG. 3), the PES packets sent in process 830 and the dummy P-frames sent in process 826 are combined with PAT, PMT and PCR streams to create an MPEG2 transport stream. The data from each stream is broken up and stored in the payload of 188-byte TS packets. All the TS packets are queued and the transport stream is constructed by taking TS packets out of the queues. The queuing

provides a buffering function to handle short bursts where TS packets arrive faster than they can be output to the transport stream. The bandwidth regulation ensures that the average data rate is less than the output rate.

The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously many modifications and variations will be apparent to practitioners skilled in this art. It is intended that the scope of the invention be defined by the following claims and their equivalents.